Fact Sheet

Dairy Manure Biogas Production Projects ("Dairy Digesters")

Issue:

Manure produced by California's dairies can be used to produce biogas. After treatment, captured biogas can be used to meet on-dairy heat and electricity needs, sold to utilities when there is electricity in excess of on-dairy demand, or sold to third parties that operate natural gas pipeline injection projects or vehicle fueling stations.

The use of biogas for energy production reduces greenhouse gas (GHG) emissions by about 85 percent and provides opportunities for meeting California's Renewable Portfolio Standard. As the multiple benefits of producing energy from manure and other biomass feedstocks become more apparent, it is expected that the interest in their use for production of energy will increase.

The conversion of dairy manure and other biomass feedstocks into energy does not occur without air quality impacts. Combustion of biogas results in an increase in criteria pollutant emissions, particularly oxides of nitrogen (NO_x), which is a precursor to regional ozone. Areas such as the San Joaquin Valley Air Pollution Control District (SJVAPCD) and the South Coast Air Quality Management District (SCAQMD) are designated extreme nonattainment for ozone. Federal and State New Source Review requirements in these districts and other areas of the State mandate stringent emission controls that are costly not only to purchase and install but to maintain and operate as well.

Background:

1. What are dairy manure biogas production projects?

Dairy manure biogas production projects consist of anaerobic digesters (digester), gas treatment systems, energy production equipment, and emergency flares. Digesters are in-ground covered lagoons, or above-ground stainless steel or concrete tanks. Manure placed in a digester is anaerobically broken down to produce biogas. Impurities in the biogas must be removed by a gas treatment system before it can be used to produce energy. Treated biogas can be used in engines, turbines, or fuel cells to produce electricity and/or heat for on-dairy use; injected into a natural gas transmission pipeline; or used as vehicle fuel. Emergency flares are used to combust biogas that is in excess of the storage capacity of the digester or cannot be routed to the gas treatment or energy production equipment because of malfunction or maintenance issues.

2. Why do dairies use digesters?

California is home to about 1.7 million dairy cows and 2,000 dairies. The resulting manure (about 115 pounds per head a day) accounts for about 1.4 percent of the total GHG emissions in California.

Digesters provide an oxygen-free environment in which bacteria break down dairy manure into biogas and other byproducts. Digesters capture and store methane-containing biogas that would otherwise be released to the atmosphere from milking parlors, animal enclosures, or uncovered manure storage lagoons. After treatment, captured biogas can be used for energy production. The use of biogas for energy production reduces GHG emissions by about 85 percent by converting treated biogas into combustion byproducts with less global-warming potential.

It is estimated that 15 billion standard cubic feet of pipeline quality natural gas could be produced per year from all of the available dairy manure in California. This represents less than one percent of California's current annual demand for natural gas. It is estimated that a potential of 160 megawatts could be produced if all of the available dairy manure were converted into electricity. This represents less than one percent of California's peak demand for electricity. If all of the manure from dairy cows were converted into vehicle fuel, the equivalent of 72 million gallons of diesel fuel could be produced. This represents less than two percent of California's annual demand for diesel fuel.

3. Why must biogas be treated before it is used in energy production equipment?

The biogas that results from anaerobic digestion contains substances that can corrode equipment and pipelines, increase maintenance requirements, deactivate air pollution control systems, and decrease the energy content of the gas.

4. What are the air quality requirements for dairy manure biogas production projects?

Twenty of California's 35 independent local air pollution control and air quality management districts (district) are required to develop state implementation plans (SIP) that establish the framework for meeting federal ambient air quality standards. The SJVAPCD and SCAQMD are designated as extreme "nonattainment" for the federal ozone standard. As required by the United States Environmental Protection Agency (U.S. EPA), the district has prepared a SIP that includes aggressive measures to reduce emissions of NO_x, a precursor to ozone. The SIP commits the district to adopt new and more stringent rules to reduce NO_x emissions. All owners and operators of

energy production equipment are required to install best available control technology (BACT) to reduce NO_x emissions. BACT is the cleanest, state-of-the-art technology that has been demonstrated to be achieved in practice or is technically feasible and cost effective.

In addition to district rules aimed at achieving ambient air quality standards, Assembly Bill 32, the California Global Warming Solutions Act of 2006 (AB 32), required the Air Resources Board (ARB) to develop a comprehensive program to reduce GHGs. AB 32 requires that activities taken to reduce GHGs cannot interfere with existing efforts to achieve and maintain State and federal ambient air quality standards. The AB 32 Scoping Plan recommends a voluntary measure for methane capture at dairies through the use of manure digesters. This approach is designed to encourage voluntary investment in manure digesters and provide information about cost-effectiveness over time. The extent of voluntary investment will be assessed in the five-year Scoping Plan update in 2013 to determine if the measure should be made mandatory by 2020.

5. Can dairy manure biogas production projects comply with current air quality requirements?

Dairy manure biogas production projects consist of digesters, gas treatment systems, energy production equipment, and emergency flares. Typically, digesters and gas treatment systems are not sources of NO_x emissions. However, energy production equipment and emergency flares do emit NO_x. By combining state-of-the-art gas clean-up systems, energy production equipment, and air pollution controls, biogas production projects can comply with air quality requirements. However, compliant equipment is more expensive to purchase, operate, and maintain than the typical internal combustion engine that has been historically used

Feasible options that meet district BACT requirements include: internal combustion engines with add-on NO_X control such as selective catalytic reduction, injection of the biogas into a utility natural gas pipeline, microturbines, gas turbines equipped with add-on NO_X controls, stationary fuel cells, and the use of biogas for vehicles and trucks.

Many of the issues associated with the permitting of dairy manure biogas production projects have been related to trying to retrofit existing operations to meet district BACT requirements. Because these systems are not designed to meet low emission targets, retrofitting existing equipment is much more technically challenging. Districts have been working with applicants to provide flexibility in reducing emissions to the greatest extent possible for existing equipment.

Going forward, new dairy manure biogas production projects will be subject to BACT and will need to be designed from the ground up to meet stringent emission targets. Under federal law, BACT is required on new and modified sources and represents the most stringent level of control that is achieved in practice or is technologically feasible and cost effective. Once BACT is triggered for a project, the level of control cannot be

reduced by other means such as providing offsets to make up for a lesser degree of control.

In addition to the technologies listed above, there are a couple of very promising technologies that are currently being tested that have the potential to lower costs and still meet BACT requirements.

6. How much does it cost to build and operate state-of-the-art dairy manure biogas production projects that meet air quality requirements?

It is estimated that a dairy manure biogas production project costs $2.5-4.3 million for a dairy with at least 1,000 head of cows. These costs include the digester, gas treatment system, energy production equipment, and emergency flares.

Dairies have relied upon incentive funding for the building and operation of dairy manure biogas production projects. For example, in 2001, the average amount of funding received was approximately 35 percent per project through the Dairy Power Production Program. Like other businesses in California, the dairy industry is affected by the current economic downturn. Feed and construction prices have gone up, while the price paid to dairies for milk has fallen. In today's economic conditions it would be very difficult for dairies to construct and operate a state-of-the-art dairy biogas production project without incentive funding.

7. What is the estimated annual revenue that could be generated from dairy manure biogas production projects?

The estimated annual revenue that could be generated from a dairy manure biogas production project at a 1,000 head dairy is summarized in the table below.

Revenue Source		**Amount**
Biogas sold as pipeline quality gas		$70,000 (@ $8/MMBtu)
Biogas sold/used as vehicle fuel		Equiv. to 42,000 gallons of diesel fuel
Biogas sold/used as electricity	Sold to the grid	$50,000 (@ 7.5¢/kWh)
	Used on-dairy	$70,000 (@ 11¢/kWh)
GHG credit		$30,000 (@ $10/metric tonne CO_2E)

8. What incentive programs have been made available for dairy manure biogas production projects?

There are a number of incentive programs that have been made available to offset the costs of building and operating dairy manure biogas production projects. Some of these programs are summarized in the table below.

Funding Source	Amount
California Energy Commission Dairy Power Production Program Subsidy	Up to 50% of the total capital costs
Pacific Gas & Electric Company, San Diego Regional Energy Office, Southern California Edison, and Southern California Gas Company Self-Generation Incentive Program for Renewable Fuel Cells	Up to 50% of the total capital costs
United States Department of Agriculture Renewable Energy and Energy Efficiency Improvements Program	Up to $500,000
State Water Resources Control Board 319 Program	Up to $350,000
State Assistance Fund for Enterprise, Business and Industrial Development Corporation Small Business Loans	Up to $350,000
USDA National Resources Conservation Service Environmental Quality Incentives Program (EQIP)	Up to $300,000
Sustainable Agriculture Research and Education Grant Program	Up to $10,000

9. What do we know about the currently operating dairy manure biogas production projects?

A number of dairy manure biogas production projects are in various stages of planning, construction, or operation in California. The attached document provides a summary of these facilities. With two exceptions, these projects use the captured biogas to generate electricity. The exceptions are: Vintage Dairy injects treated biogas into the natural gas transmission pipeline; and Hilarides Dairy produces fuel for its vehicles in addition to producing electricity. Some owners/operators have indicated that they have elected to cease operation of the energy production part of the project because they did not receive enough money from electricity sales. An additional five dairy manure biogas production projects are in the development phase.